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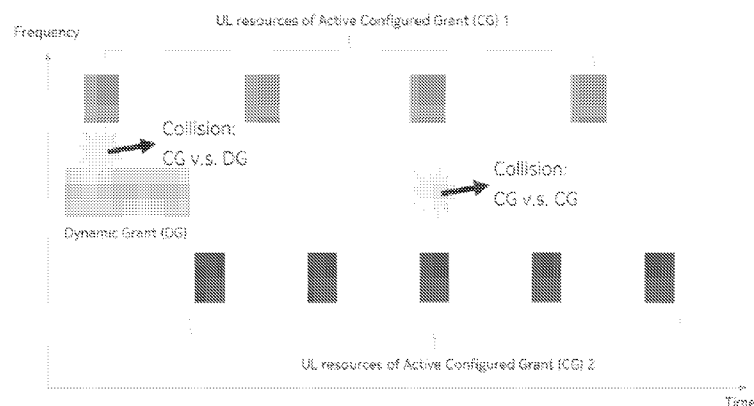


Fig. 1

(57) Abstract: Systems, methods, apparatuses, and computer program products for handling of overlapping grants for the same user equipment are provided. First and second logical channels or first and second types of MAC control elements are assigned to first and second grants, respectively. In case of overlapping grants for logical channels, data units are constructed based on logical channel priority. Transmission of data associated with a logical channel may be interrupted.

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TITLE:

HANDLING OF OVERLAPPING GRANTS FOR THE SAME USER EQUIPMENT

5 FIELD:

[0001] Some example embodiments may generally relate to mobile or wireless telecommunication systems, such as Long Term Evolution (LTE) or fifth generation (5G) radio access technology or new radio (NR) access technology, or other communications systems. For example, certain example embodiments may relate to systems and/or methods for efficient handling of overlapping grants for the same user equipment (UE).

BACKGROUND:

[0002] Examples of mobile or wireless telecommunication systems may include the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN), Long Term Evolution (LTE) Evolved UTRAN (E-UTRAN), LTE-Advanced (LTE-A), MulteFire, LTE-A Pro, and/or fifth generation (5G) radio access technology or new radio (NR) access technology. Fifth generation (5G) wireless systems refer to the next generation (NG) of radio systems and network architecture. 5G is mostly built on a new radio (NR), but the 5G (or NG) network can also build on E-UTRA radio. It is estimated that NR will provide bitrates on the order of 10-20 Gbit/s or higher, and will support at least enhanced mobile broadband (eMBB) and ultra-reliable low-latency-communication (URLLC) as well as massive machine type communication (mMTC). NR is expected to deliver extreme broadband and ultra-robust, low latency connectivity and massive networking to support the Internet of Things (IoT). With IoT and machine-to-machine (M2M) communication becoming more widespread, there will be a growing need for networks that meet the needs of lower power, low data rate, and long battery life. It is noted that, in 5G, the nodes that can provide radio access functionality to a user equipment (i.e., similar to

Node B in UTRAN or eNB in LTE) may be named gNB when built on NR radio and may be named NG-eNB when built on E-UTRA radio.

BRIEF DESCRIPTION OF THE DRAWINGS:

5 [0003] For proper understanding of example embodiments, reference should be made to the accompanying drawings, wherein:

[0004] Fig. 1 illustrates an example of resource collision among configured grants (CG), and/or CG and dynamic grants (DG), according to one example embodiment;

10 [0010] Fig. 2 illustrates an example flow diagram of a method, according to an example embodiment;

[0011] Fig. 3 illustrates an example flow diagram of another method, according to another example embodiment;

[0012] Fig. 4a illustrates an example block diagram of an apparatus, according to an example embodiment; and

15 [0013] Fig. 4b illustrates an example block diagram of another apparatus, according to an example embodiment.

DETAILED DESCRIPTION:

20 [0014] It will be readily understood that the components of certain example embodiments, as generally described and illustrated in the figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the following detailed description of some example embodiments of systems, methods, apparatuses, and computer program products for beam pair link selection and/or indication, is not intended to limit the scope of certain embodiments but is
25 representative of selected example embodiments.

[0015] The features, structures, or characteristics of example embodiments described throughout this specification may be combined in any suitable manner in one or more example embodiments. For example, the usage of the phrases “certain embodiments,” “some embodiments,” or other similar language, throughout this
30 specification refers to the fact that a particular feature, structure, or characteristic

described in connection with an embodiment may be included in at least one embodiment. Thus, appearances of the phrases “in certain embodiments,” “in some embodiments,” “in other embodiments,” or other similar language, throughout this specification do not necessarily all refer to the same group of embodiments, and the described features, structures, or characteristics may be combined in any suitable manner in one or more example embodiments.

[0016] Additionally, if desired, the different functions or steps discussed below may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the described functions or steps may be optional or may be combined. As such, the following description should be considered as merely illustrative of the principles and teachings of certain example embodiments, and not in limitation thereof.

[0017] Uplink (UL) transmission based on configured grants (CG) supports ultra-reliable low latency communication (URLLC) in 5G NR, and has been adopted in Rel-15 to reduce potential latency caused by scheduling request/buffer status report (SR/BSR) procedures as in earlier versions of 3GPP radio access systems. With CG, UL resources may be pre-allocated and occur in a periodic manner, and the UE may utilize these pre-allocated resources for UL transmission whenever it is available without needing to wait for a scheduling grant from a 5G NodeB (gNB). Further, in Rel-15, one single CG may be activated in each bandwidth part (BWP) per serving cell. In addition, Rel-16 describes that multiple active CGs may be supported per BWP.

[0018] The CG supported by 5G NR may be classified into two types, namely Type-1 and Type-2. In Type-1, CG is solely configured by the radio resource control (RRC) signaling, and is activated as soon as the RRC configuration is completed. In Type-2, CG is configured by the RRC signaling, but it is dynamically activated and/or deactivated (along with any remaining scheduling information) by layer-1 (L1) signaling. In both cases, the gNB may assign a set of parameters such as modulation and coding scheme (MCS), transport block size (TBS), resource size/timing, and

power-related settings to each grant. The assignment of these parameters may enable the UE to use these grants properly.

[0019] In certain URLLC cases, the network may configure CGs even when there is no instantaneous need from the UE to have those configurations. For example, a case where there is no instantaneous need may occur when there is no data to be sent from the UE. A reason for this may be that, for URLLC applications, to meet their certain delay requirements, there is no time to perform scheduling requests (SR) from the UE and wait for the related UL grant from gNB. Thus, with CGs, the resources may be made available quickly enough to meet the delay requirement. On the other hand, in case they are not used for periodic traffic, it would be wasteful from the overall system perspective if they were constantly blocked, and the resource is exclusively allocated to one UE for one type of traffic only.

[0020] In the above situation, the gNB may still assign resources for different types of traffic, including, for example, lower priority traffic ongoing in the UE. In Rel-15, a method was developed for inter-UE multiplexing to pre-empt downlink (DL) lower priority traffic from another UE with higher priority traffic. However, for an intra-UE case where traffic with different priorities co-exist in the single UE, for simplicity, dynamic UL grant always takes precedence over CG in case they overlap in time. In Rel-15, only one physical uplink shared channel (PUSCH) may be transmitted at a time because a UE does not support parallel PUSCH transmissions overlapping in time even if frequency allocations for the grants are not overlapping.

[0021] Since CGs may often be used for URLLC, such rule may often lead to lower priority traffic taking precedence over higher priority traffic that was generated by the UE at a later time. Fig. 1 illustrates a problem of resource collision among CGs and CG and/or dynamic grants (DG).

[0022] One proposal to resolve the resource conflict is for each logical channel (LC/LCH) and each grant to be configured with a transmission profile (TP) value. When the medium access control (MAC) attempts to construct a MAC packet data unit (PDU) for a grant, it should only take the LCHs with the TP values matching that of the grant into consideration. When the collision between two or more grants occur,

the UE may prioritize the grant with a configured TP value matching the TP configured for the highest priority LCH with buffered data to transmit. This method requires configuration of TP values for each LCH as well as each CG grant configuration, which is not efficient in terms of configuration signaling overhead.

5 **[0023]** According to an example embodiment, a method may be provided which would allow avoiding priorities assignment to the grants themselves. This may be achieved by considering priority of the traffic to be carried by the grant directly when making the decision on whether to override the previous grant or ongoing transmission. For example this may be done as part of a logical channel prioritization
10 (LCP) procedure.

[0024] In an example embodiment, a method may be provided for the MAC layer of a UE to determine how a grant (either dynamic grant or configured grant) should be handled (e.g., drop or proceed) when its radio resource overlaps in time (same or different frequencies) with another processed grant. The another grant processed,
15 may, for example, relate to a corresponding MAC PDU that has already been constructed and/or provided for transmission to lower layers previously. Further, the determination of how the grant should be handled may be done based on the contents of the previously constructed MAC PDU. In certain example embodiments, the contents may be referred to MAC service data units (SDUs) and/or MAC control
20 elements (CEs) relevant to at least one logical channel.

[0025] Certain example embodiments provide a modification on MAC layer processing of grants. For example, it may be assumed that a UE may or may not be capable of simultaneous PUSCH transmissions that overlap in the time domain but at non-overlapping frequency locations on a single carrier. In such a case, the UE may
25 be capable of transmitting N PUSCHs that overlap in time on a single (component) carrier, where $N=1$ means that the UE is not capable of simultaneous PUSCH transmissions.

[0026] According to certain example embodiments, each grant for which the UE generated a MAC PDU and for which the PUSCH transmission has not been
30 completed (i.e., either has not started yet or is ongoing), the UE may store certain

elements in its memory. For example, one element may include the PUSCH duration of the grant, which may include a starting and stopping point in time. Another element may include the highest priority of the logical channel for which data is included in this MAC PDU. Another element may include the highest priority of the logical channels relevant to at least one MAC CEs included in this MAC PDU. In one example embodiment, the logical channel may refer to logical channel carrying user data and/or control channel data and/or MAC CEs.

[0027] In NR, the priorities between logical channels carrying user data may be determined by the priority as configured by the network. The determination of priority between LCs carrying user data and LCs carrying control information (e.g., MAC CEs, common control channels (CCCHs)) and between different LCs carrying control information, may be based on the rules specified in 3GPP technical specification (TS) 38.312, section 5.4.3.1.3. specifically, LCs may be prioritized in accordance with the following order (highest priority listed first): C-RNTI MAC CE or data from UL-CCCH; configured grant configuration MAC CE; MAC CE for BSR, with exception of BSR included for padding; single entry PHR MAC CE or multiple entry PHR MAC CE; data from any LC, except data from UL-CCCH; MAC CE for recommended bit rate query; and MAC CE for BSR included for padding.

[0028] According to certain example embodiments, the UE may process the received grant (either dynamic or configured grant) regardless of whether it overlaps with any of the previously received grants. Here, “overlapping grants” may refer to PUSCH durations as provided by the grants overlap with each other (see Fig. 1) in the ways described below. For instance, if the grant does not overlap with more than N-1 previous grants applying to the same component carrier (that had been processed and not pre-empted by another grant) in time, normal processing is applied.

[0029] However if the grant overlaps in the time domain with more than N-1 previous grants for the same component carrier (the grant may overlap with multiple grants in case UE is capable of simultaneous PUSCH transmissions), the UE may check the priority of a highest priority LC which has data available that can be mapped to this grant, or alternatively the priority of a highest priority LC of a set of

LCs that is relevant to at least one MAC CE that is to be conveyed by this grant. Here, the value of this priority level may be denoted as, for example, *Prio_new*. The UE may then compare this priority value with the priority value of the highest priority LC that has been mapped to the previous grant(s).

5 **[0030]** During the comparison, if it is determined that the value of *Prio_new* indicates a priority higher than the priority of the highest priority logical channel mapped to one or more of the previous grants, the UE may process the new grant further using a normal LCP procedure. For example, the UE may construct a MAC PDU and deliver it to the physical layer for transmission. If the total number of
10 overlapping PUSCH transmissions at any time now exceeds *N*, the UE may additionally indicate to the physical layer which of the previous grant/transmission should be pre-empted. For example, the UE may either abandon or stop, or puncture the ongoing PUSCH transmission for this grant.

15 **[0031]** In the case where the grant was associated to one of the repetitions within a bundle of transmissions of a single transport block (TB), the UE may continue the transmission of the rest of the repetitions. In an example embodiment, the indication may be based on the priority of the highest priority LC mapped to this grant (i.e., the grant for which the priority value of the highest priority LC was lowest should be pre-empted). Alternatively, in another example embodiment, the UE may indicate to the
20 physical layer the priority value of the highest priority LC mapped to each grant, and the physical layer may decide which one(s) to pre-empt, when needed, based on the priority values.

25 **[0032]** According to another example embodiment, there may be provided a situation where it is determined that *Prio_new* is lower than the priority of the highest priority LC mapped to all the previous grants. In such a case, if the total number of overlapping PUSCH transmission at any time after including the new grant does not exceed *N*, normal processing is applied. Otherwise, the UE does not process the grant further, and the transmission(s) related to the previous grant(s) is/are not pre-empted. Alternatively, in other example embodiments, the grant may be processed at a later
30 time or processed with low priority.

[0033] In addition to comparing the LC priorities as configured by the network for LCs carrying user data, if the grant overlaps with $N \geq 1$ grants in case the UE is capable of transmitting $N \geq 1$ PUSCH simultaneously, MAC may determine whether MAC PDU will be generated based not only on logical channel priorities as configured by the network for LCs carrying user data, but also based on the relative priorities to other LCs. For example, the UE may consider relative priorities of LCs associated with MAC CEs that have been included in the MAC PDU (if any) corresponding to this new grant and previous grant(s).

[0034] In certain example embodiments, additional rules may also apply. For example, the priority of the MAC PDU carrying BSR with respect to LCs carrying user data may depend on whether the BSR concerns LCs with higher priority than those carried by previous grants. If the MAC PDU corresponding to the previous grant(s) does not include data of higher priority LC(s), but includes the BSR (a type of MAC CE) of LCs with higher priority, the UE may still drop the new grant and not pre-empt the previous grant. As another example, if the MAC PDU corresponding to the new grant does not include data of higher priority LC(s), but includes the BSR (a type of MAC CE) of LCs with higher priority, the UE may process the new grant and may pre-empt a previous grant. The embodiments can cover other type(s) of control information as well other than BSR.

[0035] In certain example embodiments, how the UE should handle this grant could be configured by the network. For example, the UE may be configured to abandon this grant directly, or process this grant directly, or determine whether this grant should be processed by comparing *Prio_new* only with the priority of the highest priority LC mapped to all the previous grants, or by comparing *Prio_new* only with the priority of the highest priority LC relevant to MAC CEs (e.g., BSR) included in MAC PDUs corresponding to all the previous grants, or comparing *Prio_new* with both of these.

[0036] According to other example embodiments, in addition to the procedures described above, additional procedures may be included that allow for extra flexibility. For example, the UE (specifically the MAC layer) in certain example

embodiments may temporarily store the information relating to the contents of constructed MAC PDUs in order to facilitate deciding whether a newly received grant by the UE should be dropped or processed further in cases of collision. To enable more efficient storage resource utilization within the device, the system may restrict each grant by, for example, RRC configurations, only to convey certain subset of LCs.

[0037] Similar mechanisms are already in place in Rel-15 specifications (LCP restrictions), but it could be further extended. For instance, according to certain example embodiments, for a UE with multiple active configured grants (potentially with different configurations such as periodicity, MCS, TBS, etc.), each of these active configured grants may be restricted to carry a specific set of LCs corresponding to different traffic types.

[0038] As one example, a UE may have two active configured grants restricted to URLLC and voice IP (VoIP) traffics respectively. In Configured Grant 1, the configuration (resource, etc.) is restricted to LCs associating to URLLC. Further, in Configured Grant 2, the configuration (resource, etc.) is restricted to LCs associating to VoIP. This configuration may be appropriate since different traffic types have different quality of service (QoS) requirements, and it is practical to map them to appropriate resource configurations to ensure appropriate usage of the radio resources. Moreover, with such restrictions in place, when collision (e.g., overlapping resource between two configured grants) occurs, the UE may simply decide the priority based on the colliding grants configurations (which implies the traffic priority such a grant could convey), instead of looking into the actual contents in the previously constructed MAC PDUs.

[0039] According to certain example embodiments, the above-described mechanisms (LC priority comparison and LC restriction per grant) may be jointly applied, especially when some LCs are not exclusively restricted to any grant configuration. The joint application of both mechanisms may bring more benefit for supporting high priority traffic. For example, the high priority LCs associated with the VoIP may be mapped to Configured Grant 2 only. The same decision mechanism

based on the priority of the configured grant may be equally applied in the prioritization of overlapping configured and dynamic grant transmissions.

[0040] In certain example embodiments, a UE may further be configured to restrict the MAC CE types/contents that could be conveyed by each grant. For instance, for a grant targeting to carry high priority traffics, the MAC CEs this grant can take may be configured and limited to BSR relating to high priority LC and/or logical channel groups (LCGs). Thus, the assurance that any content conveyed by the corresponding MAC PDU (comprises MAC SDUs and MAC CEs) of such a grant may always be associated with information relating to high priority traffics, can be achieved, thereby avoiding potential interruption by any other colliding grants conveying lower priority traffics.

[0041] Fig. 2 illustrates an example flow diagram of a method according to an example embodiment. In certain example embodiments, the flow diagram of Fig. 2 may be performed by a mobile station and/or UE, for instance. According to one embodiment, the method of Fig. 2 may include initially, at 200, processing data associated with multiple logical channels applicable to a device. The method may also include, at 205, constructing a first data unit based on data associated with a first set of logical channels. In addition, the method may include, at 210, sending the first data unit to a lower layer for transmission. For instance, in one example embodiment, the lower layer may represent a physical layer or layer-1.

[0042] In an example embodiment, the method of Fig. 2 may further include, at 215, detecting the availability of data associated with a second set of logical channels. The method may then include, at 220, determining if a second data unit should be constructed and sent to the lower layer for transmission. In addition, the method may include, at 225, determining if transmission of the first data unit should be interrupted. According to certain example embodiments, the determination of whether the second data unit should be constructed and sent to the lower layer, and whether transmission of the first data unit should be interrupted may be made based at least on the data associated with the first set and the second set of logical channels.

[0043] Fig. 3 illustrates an example flow diagram of a method according to another example embodiment. In certain example embodiments, the flow diagram of Fig. 3 may be performed by a network entity or network node in a 3GPP system, such as LTE or 5G NR. For instance, in some example embodiments, the method of Fig. 3 may be performed by a base station, eNB, or gNB.

[0044] According to one example embodiment, the method of Fig. 3 may include initially, at 300, handling a plurality of uplink grants applicable to a communication station. The method may also include, at 305, assigning a first set of types of medium access control element contents to a first uplink grant. In addition, the method may include, at 310, assigning a second set of types of medium access control element contents to a second uplink grant. The method may then include, at 315, sending at least one information relating to the assignment of the first uplink grant and the second uplink grant to a communication device. In certain example embodiments, the communication device may include a mobile station and/or UE, for instance.

[0045] Fig. 4a illustrates an example of an apparatus 10 according to an example embodiment. In an example embodiment, apparatus 10 may be a node, host, or server in a communication network or serving such a network. For example, apparatus 10 may be a satellite, base station, a Node B, an evolved Node B (eNB), 5G Node B or access point, next generation Node B (NG-NB or gNB), and/or WLAN access point, associated with a radio access network (RAN), such as an LTE network, 5G or NR. In certain example embodiments, apparatus 10 may be an eNB in LTE or gNB in 5G.

[0046] It should be understood that, in some example embodiments, apparatus 10 may be comprised of an edge cloud server as a distributed computing system where the server and the radio node may be stand-alone apparatuses communicating with each other via a radio path or via a wired connection, or they may be located in a same entity communicating via a wired connection. For instance, in certain example embodiments where apparatus 10 represents a gNB, it may be configured in a central unit (CU) and distributed unit (DU) architecture that divides the gNB functionality. In such an architecture, the CU may be a logical node that includes gNB functions such as transfer of user data, mobility control, radio access network sharing,

positioning, and/or session management, etc. The CU may control the operation of DU(s) over a front-haul interface. The DU may be a logical node that includes a subset of the gNB functions, depending on the functional split option. It should be noted that one of ordinary skill in the art would understand that apparatus 10 may include components or features not shown in Fig. 4a.

[0047] As illustrated in the example of Fig. 4a, apparatus 10 may include a processor 12 for processing information and executing instructions or operations. Processor 12 may be any type of general or specific purpose processor. For example, processor 12 may include one or more of general-purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and processors based on a multi-core processor architecture, as examples. While a single processor 12 is shown in Fig. 4a, multiple processors may be utilized according to other embodiments. For example, it should be understood that, in certain embodiments, apparatus 10 may include two or more processors that may form a multiprocessor system (e.g., in this case processor 12 may represent a multiprocessor) that may support multiprocessing. In certain embodiments, the multiprocessor system may be tightly coupled or loosely coupled (e.g., to form a computer cluster).

[0048] According to certain example embodiments, processor 12 may perform functions associated with the operation of apparatus 10, which may include, for example, precoding of antenna gain/phase parameters, encoding and decoding of individual bits forming a communication message, formatting of information, and overall control of the apparatus 10, including processes related to management of communication resources.

[0049] Apparatus 10 may further include or be coupled to a memory 14 (internal or external), which may be coupled to processor 12, for storing information and instructions that may be executed by processor 12. Memory 14 may be one or more memories and of any type suitable to the local application environment, and may be implemented using any suitable volatile or nonvolatile data storage technology such as a semiconductor-based memory device, a magnetic memory device and system, an

optical memory device and system, fixed memory, and/or removable memory. For example, memory 14 can be comprised of any combination of random access memory (RAM), read only memory (ROM), static storage such as a magnetic or optical disk, hard disk drive (HDD), or any other type of non-transitory machine or computer readable media. The instructions stored in memory 14 may include program instructions or computer program code that, when executed by processor 12, enable the apparatus 10 to perform tasks as described herein.

[0050] In an embodiment, apparatus 10 may further include or be coupled to (internal or external) a drive or port that is configured to accept and read an external computer readable storage medium, such as an optical disc, USB drive, flash drive, or any other storage medium. For example, the external computer readable storage medium may store a computer program or software for execution by processor 12 and/or apparatus 10.

[0051] In certain example embodiments, apparatus 10 may also include or be coupled to one or more antennas 15 for transmitting and receiving signals and/or data to and from apparatus 10. Apparatus 10 may further include or be coupled to a transceiver 18 configured to transmit and receive information. The transceiver 18 may include, for example, a plurality of radio interfaces that may be coupled to the antenna(s) 15. The radio interfaces may correspond to a plurality of radio access technologies including one or more of GSM, NB-IoT, LTE, 5G, WLAN, Bluetooth, BT-LE, NFC, radio frequency identifier (RFID), ultrawideband (UWB), MulteFire, and the like. The radio interface may include components, such as filters, converters (for example, digital-to-analog converters and the like), mappers, a Fast Fourier Transform (FFT) module, and the like, to generate symbols for a transmission via one or more downlinks and to receive symbols (for example, via an uplink).

[0052] As such, transceiver 18 may be configured to modulate information on to a carrier waveform for transmission by the antenna(s) 15 and demodulate information received via the antenna(s) 15 for further processing by other elements of apparatus 10. In other embodiments, transceiver 18 may be capable of transmitting and

receiving signals or data directly. Additionally or alternatively, in some embodiments, apparatus 10 may include an input and/or output device (I/O device).

[0053] In an embodiment, memory 14 may store software modules that provide functionality when executed by processor 12. The modules may include, for example, an operating system that provides operating system functionality for apparatus 10. The memory may also store one or more functional modules, such as an application or program, to provide additional functionality for apparatus 10. The components of apparatus 10 may be implemented in hardware, or as any suitable combination of hardware and software.

[0054] According to some embodiments, processor 12 and memory 14 may be included in or may form a part of processing circuitry or control circuitry. In addition, in some embodiments, transceiver 18 may be included in or may form a part of transceiving circuitry.

[0055] As used herein, the term “circuitry” may refer to hardware-only circuitry implementations (e.g., analog and/or digital circuitry), combinations of hardware circuits and software, combinations of analog and/or digital hardware circuits with software/firmware, any portions of hardware processor(s) with software (including digital signal processors) that work together to case an apparatus (e.g., apparatus 10) to perform various functions, and/or hardware circuit(s) and/or processor(s), or portions thereof, that use software for operation but where the software may not be present when it is not needed for operation. As a further example, as used herein, the term “circuitry” may also cover an implementation of merely a hardware circuit or processor (or multiple processors), or portion of a hardware circuit or processor, and its accompanying software and/or firmware. The term circuitry may also cover, for example, a baseband integrated circuit in a server, cellular network node or device, or other computing or network device.

[0056] As introduced above, in certain embodiments, apparatus 10 may be a network node or RAN node, such as a base station, access point, Node B, eNB, gNB, WLAN access point, or the like. According to certain embodiments, apparatus 10 may be controlled by memory 14 and processor 12 to perform the functions

associated with any of the embodiments described herein, such as the flow or signaling diagrams illustrated in Figs. 2 and 3. In some embodiments, apparatus 10 may be configured to perform a procedure for handling multiple uplink grants applicable to a communication station, for example.

5 **[0057]** For instance, in one embodiment, apparatus 10 may be controlled by memory 14 and processor 12 to handle a plurality of uplink grants applicable to a communication station. The apparatus 10 may also be controlled by memory 14 and processor 12 to assign a first type of medium access control element contents to a first uplink grant, and assign a second set of medium access control element contents
10 to a second uplink grant. In addition, the apparatus 10 may be controlled by memory 14 and processor 12 to send at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

[0058] Fig. 4b illustrates an example of an apparatus 20 according to another embodiment. In an embodiment, apparatus 20 may be a node or element in a
15 communications network or associated with such a network, such as a UE, mobile equipment (ME), mobile station, mobile device, stationary device, IoT device, or other device. As described herein, UE may alternatively be referred to as, for example, a mobile station, mobile equipment, mobile unit, mobile device, user device, subscriber station, wireless terminal, tablet, smart phone, IoT device, sensor
20 or NB-IoT device, or the like. As one example, apparatus 20 may be implemented in, for instance, a wireless handheld device, a wireless plug-in accessory, or the like.

[0059] In some example embodiments, apparatus 20 may include one or more processors, one or more computer-readable storage medium (for example, memory, storage, or the like), one or more radio access components (for example, a modem, a
25 transceiver, or the like), and/or a user interface. In some embodiments, apparatus 20 may be configured to operate using one or more radio access technologies, such as GSM, LTE, LTE-A, NR, 5G, WLAN, WiFi, NB-IoT, Bluetooth, NFC, MulteFire, and/or any other radio access technologies. It should be noted that one of ordinary skill in the art would understand that apparatus 20 may include components or
30 features not shown in Fig. 4b.

[0060] As illustrated in the example of Fig. 4b, apparatus 20 may include or be coupled to a processor 22 for processing information and executing instructions or operations. Processor 22 may be any type of general or specific purpose processor. In fact, processor 22 may include one or more of general-purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and processors based on a multi-core processor architecture, as examples. While a single processor 22 is shown in Fig. 4b, multiple processors may be utilized according to other embodiments. For example, it should be understood that, in certain example

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embodiments, apparatus 20 may include two or more processors that may form a multiprocessor system (e.g., in this case processor 22 may represent a multiprocessor) that may support multiprocessing. According to certain example embodiments, the multiprocessor system may be tightly coupled or loosely coupled (e.g., to form a computer cluster).

[0061] Processor 22 may perform functions associated with the operation of apparatus 20 including, as some examples, precoding of antenna gain/phase parameters, encoding and decoding of individual bits forming a communication message, formatting of information, and overall control of the apparatus 20, including processes related to management of communication resources.

[0062] Apparatus 20 may further include or be coupled to a memory 24 (internal or external), which may be coupled to processor 22, for storing information and instructions that may be executed by processor 22. Memory 24 may be one or more memories and of any type suitable to the local application environment, and may be implemented using any suitable volatile or nonvolatile data storage technology such as a semiconductor-based memory device, a magnetic memory device and system, an optical memory device and system, fixed memory, and/or removable memory. For example, memory 24 can be comprised of any combination of random access memory (RAM), read only memory (ROM), static storage such as a magnetic or optical disk, hard disk drive (HDD), or any other type of non-transitory machine or computer readable media. The instructions stored in memory 24 may include program

instructions or computer program code that, when executed by processor 22, enable the apparatus 20 to perform tasks as described herein.

[0063] In an embodiment, apparatus 20 may further include or be coupled to (internal or external) a drive or port that is configured to accept and read an external computer readable storage medium, such as an optical disc, USB drive, flash drive, or any other storage medium. For example, the external computer readable storage medium may store a computer program or software for execution by processor 22 and/or apparatus 20.

[0064] In some embodiments, apparatus 20 may also include or be coupled to one or more antennas 25 for receiving a downlink signal and for transmitting via an uplink from apparatus 20. Apparatus 20 may further include a transceiver 28 configured to transmit and receive information. The transceiver 28 may also include a radio interface (e.g., a modem) coupled to the antenna 25. The radio interface may correspond to a plurality of radio access technologies including one or more of GSM, LTE, LTE-A, 5G, NR, WLAN, NB-IoT, Bluetooth, BT-LE, NFC, RFID, UWB, and the like. The radio interface may include other components, such as filters, converters (for example, digital-to-analog converters and the like), symbol demappers, signal shaping components, an Inverse Fast Fourier Transform (IFFT) module, and the like, to process symbols, such as OFDMA symbols, carried by a downlink or an uplink.

[0065] For instance, transceiver 28 may be configured to modulate information on to a carrier waveform for transmission by the antenna(s) 25 and demodulate information received via the antenna(s) 25 for further processing by other elements of apparatus 20. In other embodiments, transceiver 28 may be capable of transmitting and receiving signals or data directly. Additionally or alternatively, in some embodiments, apparatus 10 may include an input and/or output device (I/O device). In certain embodiments, apparatus 20 may further include a user interface, such as a graphical user interface or touchscreen.

[0066] In an embodiment, memory 24 stores software modules that provide functionality when executed by processor 22. The modules may include, for example, an operating system that provides operating system functionality for

apparatus 20. The memory may also store one or more functional modules, such as an application or program, to provide additional functionality for apparatus 20. The components of apparatus 20 may be implemented in hardware, or as any suitable combination of hardware and software. According to an example embodiment, apparatus 20 may optionally be configured to communicate with apparatus 10 via a wireless or wired communications link 70 according to any radio access technology, such as NR.

[0067] According to certain example embodiments, processor 22 and memory 24 may be included in or may form a part of processing circuitry or control circuitry. In addition, in some embodiments, transceiver 28 may be included in or may form a part of transceiving circuitry.

[0068] As discussed above, according to certain example embodiments, apparatus 20 may be a UE, mobile device, mobile station, ME, IoT device and/or NB-IoT device, for example. According to certain embodiments, apparatus 20 may be controlled by memory 24 and processor 22 to perform the functions associated with example embodiments described herein. For example, in some embodiments, apparatus 20 may be configured to perform one or more of the processes depicted in any of the flow charts or signaling diagrams described herein, such as the flow diagrams illustrated in Figs. 2 or 3. For example, in certain embodiments, apparatus 20 may be configured to perform a procedure of processing data associated with multiple logical channels applicable to a device, for instance.

[0069] According to some embodiments, apparatus 20 may be controlled by memory 24 and processor 22 to process data associated with multiple logical channels applicable to a device. The apparatus 20 may also be controlled by memory 24 and processor 22 to construct a first data unit based on data associated with a first set of logical channels, and send the first data unit to a lower layer for transmission. In addition, the apparatus 20 may be controlled by memory 24 and processor 22 to detect the availability of data associated with a second set of logical channels. The apparatus 20 may further be controlled by memory 24 and processor 22 to determine whether a second data unit should be constructed and sent to the lower layer for transmission,

and whether transmission of the first data unit should be interrupted. In certain example embodiments, the determination may be based at least on the data associated with the first set and second set of logical channels.

[0070] Certain example embodiments described herein provide several technical improvements, enhancements, and/or advantages. For example, certain example embodiments provide methods for efficient handling of overlapping grants for the same UE. According to certain example embodiments, this may be achieved by avoiding priorities assignment to the grants themselves, and instead consider priority of the traffic (to be) carried by the grant directly when making the decision on whether to override the previous grant or ongoing transmission. Other example embodiments provide the ability to determine how a grant should be handled based on contents of previously constructed MAC PDUs.

[0071] According to other example embodiments, it is possible to decide whether to pre-empt transmission related to a previous grant based on a priority of the traffic to be carried by the new grant compared to the priority of the traffic carried by the previous grants. However, in the schemes based on assigning priorities to the grants, a situation may occur where lower priority traffic is mapped to the grant with higher priority, which would lead to a situation of pre-empting higher priority traffic. Certain example embodiments, therefore resolve the issue of such occurrences.

[0072] Other example embodiments provide the ability to keep the prioritization procedures altogether and not dividing them into different levels (grant prioritization plus traffic prioritization). Another advantage provided by certain example embodiments, is that impact to the physical layer procedures is limited. For instance, downlink control information (DCI) signaling is not affected. Moreover, certain example embodiments may be implemented in the MAC layer, and may impact the behavior of multiple entities of MAC such as MAC entity, hybrid automatic repeat request (HARQ) entity, assembly and multiplexing entity, and HARQ processes.

[0073] In some example embodiments, the functionality of any of the methods, processes, signaling diagrams, algorithms or flow charts described herein may be implemented by software and/or computer program code or portions of code stored

in memory or other computer readable or tangible media, and executed by a processor.

[0074] In some example embodiments, an apparatus may be included or be associated with at least one software application, module, unit or entity configured as arithmetic operation(s), or as a program or portions of it (including an added or updated software routine), executed by at least one operation processor. Programs, also called program products or computer programs, including software routines, applets and macros, may be stored in any apparatus-readable data storage medium and include program instructions to perform particular tasks.

[0075] A computer program product may comprise one or more computer-executable components which, when the program is run, are configured to carry out some example embodiments. The one or more computer-executable components may be at least one software code or portions of it. Modifications and configurations required for implementing functionality of an example embodiment may be performed as routine(s), which may be implemented as added or updated software routine(s). Software routine(s) may be downloaded into the apparatus.

[0076] As an example, software or a computer program code or portions of it may be in a source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium, or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers may include a record medium, computer memory, read-only memory, photoelectrical and/or electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers. The computer readable medium or computer readable storage medium may be a non-transitory medium.

[0077] In other example embodiments, the functionality may be performed by hardware or circuitry included in an apparatus (e.g., apparatus 10 or apparatus 20), for example through the use of an application specific integrated circuit (ASIC), a programmable gate array (PGA), a field programmable gate array (FPGA), or any

other combination of hardware and software. In yet another example embodiment, the functionality may be implemented as a signal, a non-tangible means that can be carried by an electromagnetic signal downloaded from the Internet or other network.

[0078] According to an example embodiment, an apparatus, such as a node, device, or a corresponding component, may be configured as circuitry, a computer or a microprocessor, such as single-chip computer element, or as a chipset, including at least a memory for providing storage capacity used for arithmetic operation and an operation processor for executing the arithmetic operation.

[0079] Partial Glossary

10	[0080]	BSR	Buffer Status Report
	[0081]	BWP	Bandwidth Part
	[0082]	CE	Control Elements
	[0083]	CG	Configured Grant
	[0084]	DCI	Downlink Control Information
15	[0085]	DG	Dynamic Grant
	[0086]	eNB	Evolved Node B
	[0087]	gNB	5g NodeB
	[0088]	HARQ	Hybrid Automatic Repeat Request
	[0089]	L1	Layer-1
20	[0090]	LC / LCH	Logical Channels
	[0091]	LCP	Logical Channel Prioritization
	[0092]	MAC	Medium Access Control
	[0093]	MCS	Modulation and Coding Scheme
	[0094]	NR	New Radio
25	[0095]	PDU	Packet Data Unit
	[0096]	PUSCH	Physical Uplink Shared Channel
	[0097]	SR	Scheduling Request
	[0098]	QoS	Quality of Service
	[0099]	RAN	Radio Access Network
30	[00100]	RRC	Radio Resource Control

[00101]	SDU	Service Data Unit
[00102]	TBS	Transport Block Size
[00103]	TP	Transport Profile
[00104]	UE	User Equipment
[00105]	UL	Uplink
[00106]	URLLC	Ultra-Reliable Low Latency Communication
[00107]	VoIP	Voice IP

[00108] A first embodiment is directed to a method, which may include processing data associated with multiple logical channels applicable to a device. The method may also include constructing a first data unit based on data associated with the first set of logical channels, and sending the first data unit to a lower layer for transmission. In addition, the method may include detecting the availability of data associated with a second set of logical channels. The method may also include determining whether a second data unit should be constructed and sent to the lower layer for transmission, and whether transmission of the first data unit should be interrupted. In a variant, the determination may be based on the data associated with the first set of logical channels and the data associated with the second set of logical channels.

[00109] In a variant, each logical channel in the first set of logical channels has an associated priority, and each logical channel in the second set of logical channels has an associated priority.

[00110] In a variant, the first data unit comprises at least one MAC CE relating to a third set of logical channels.

[00111] In a variant, the at least one MAC CE relating to a third set of logical channels corresponds to a buffer status report.

[00112] In a variant, the second data unit comprises at least one MAC CE relating to a fourth set of logical channels.

[00113] In a variant, the at least one MAC CE relating to a fourth set of logical channels corresponds to a buffer status report.

[00114] In a variant, the determination is further based on a maximum number of uplink grants that the device can concurrently transmit, and whether the maximum number of uplink grants is greater than or equal to the number of previous grants.

[00115] In a variant, when an uplink grant of the device overlaps in a time domain with one or more previous grants, the method according to the first embodiment may include checking a first new priority of a highest priority logical channel in the second set of logical channels.

[00116] In a variant, when an uplink grant of the device overlaps in a time domain with one or more previous grants, the method according to the first embodiment may include checking a second new priority of a highest priority logical channel in the fourth set of logical channels.

[00117] In a variant, when the first new priority is higher than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the method according to the first embodiment may include processing the uplink grant using a normal logical channel prioritization and constructing the second data unit.

[00118] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is not processed further.

[00119] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is processed at a later time.

[00120] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is processed with low priority.

[00121] In a variant, when the first new priority is higher than a priority of a highest priority logical channel of the third set of logical channels, the method according to the first embodiment may include processing the uplink grant using a normal logical channel prioritization and constructing the second data unit.

[00122] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is not processed further.

[00123] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is processed at a later time.

[00124] In a variant, when the first new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is processed with low priority.

[00125] In a variant, the device is configured by a communication station to, when an uplink grant of the device overlaps in a time domain with one or more previous grants, abandoning the uplink grant directly, processing the uplink grant and constructing the second data unit directly, determining by comparing the first new priority with a priority of a highest priority logical channel of the first set of logical channels only, determining by comparing the first new priority with a priority of a highest priority logical channel of the third set of logical channels only, or determining by comparing the first new priority with a priority of a highest priority logical channel of both the first set of logical channels and the third set of logical channels.

[00126] In a variant, when the second new priority is higher than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the method according to the first embodiment may include processing the uplink grant using a normal logical channel prioritization and constructing the second data unit.

[00127] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is not processed further.

[00128] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is processed at a later time.

[00129] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is processed with low priority.

[00130] In a variant, when the second new priority is higher than a priority of a highest priority logical channel of the third set of logical channels, the method according to the first embodiment may include processing the uplink grant using a normal logical channel prioritization and constructing the second data unit.

[00131] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is not processed further.

[00132] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is processed at a later time.

[00133] In a variant, when the second new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink grant is processed with low priority.

[00134] In a variant, the device is configured by a communication station to, when an uplink grant of the device overlaps in a time domain with one or more previous grants, abandoning the uplink grant directly, processing the uplink grant and constructing the second data unit directly, determining by compare the second new priority with a priority of a highest priority logical channel of the first set of logical channels only, determining by compare the second new priority with a priority of a highest priority logical channel of the third set of logical channels only, or determining by compare the second new priority with a priority of a highest priority logical channel of both the first set of logical channels and the third set of logical channels.

[00135] A second embodiment is directed to an apparatus including at least one processor and at least one memory including computer program code. The at least one memory and computer program code may be configured, with the at least one processor, to cause the apparatus at least to process data associated with multiple

logical channels applicable to a device. The at least one memory and computer program code may be further configured, with the at least one processor, to cause the apparatus at least to construct a first data unit based on data associated with a first set of logical channels, and send the first data unit to a lower layer for transmission. The at least one memory and computer program code may also be configured, with the at least one processor, to cause the apparatus at least to determine whether a second data unit should be constructed and sent to the lower layer for transmission, and whether transmission of the first data unit should be interrupted. In a variant, the determination may be based on the data associated with the first set of logical channels and the data associated with the second set of logical channels.

[00136] A third embodiment is directed to a method that may include handling a plurality of uplink grants applicable to a communication station. The method may also include assigning a first set of types of medium access control element contents to a first uplink grant. In addition, the method may include assigning a second set of types of medium access control element contents to a second uplink grant. The method may further include sending at least one information relating to the assignment of the first uplink grant and the second uplink grant to a communication device.

[00137] In a variant, the first set of types of medium access control element contents may be associated with at least a first set of logical channels, and the second set of types of medium access control element contents may be associated with at least a second set of logical channels.

[00138] In a variant, the first set of types of medium access control element contents may correspond to a buffer status report.

[00139] In a variant, a priority may be allocated to each logical channel in the first set of logical channels, and another priority may be allocated to each logical channel in the second set of logical channels.

[00140] A fourth embodiment is directed to an apparatus including at least one processor and at least one memory comprising computer program code. The at least one memory and computer program code may be configured, with the at least one

processor, to cause the apparatus at least to handle a plurality of uplink grants applicable to a communication station. The at least one memory and computer program code may be further configured, with the at least one processor, to cause the apparatus at least to assign a first type of medium access control element contents to a first uplink grant. The at least one memory and computer program code may also be configured, with the at least one processor, to cause the apparatus at least to assign a second set of medium access control element contents to a second uplink grant. In addition, the at least one memory and computer program code may be configured, with the at least one processor, to cause the apparatus at least to send at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

[00141] A fifth embodiment is directed to an apparatus that may include circuitry configured to perform the method according to the first embodiment or the third embodiment or any of their variants.

[00142] A sixth embodiment is directed to an apparatus that may include means for performing the method according to the first embodiment or the third embodiment or any of their variants.

[00143] A seventh embodiment is directed to a computer readable medium comprising program instructions stored thereon for performing at least the method according to the first embodiment or the third embodiment or any of their variants.

[00144] One having ordinary skill in the art will readily understand that the example embodiments as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although some embodiments have been described based upon these example preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of example embodiments.

CLAIMS

1. A method, comprising:

receiving, at a communication device, a plurality of grants associated with a plurality of logical channels applicable to the communication device;

5 detecting availability of data associated with a first set of logical channels, wherein each logical channel in the first set of logical channels comprises an associated priority;

detecting availability of data associated with a second set of logical channels, wherein each logical channel in the second set of logical channels comprises an
10 associated priority;

comparing the associated priority of a logical channel in the first set of logical channels with the associated priority of a logical channel in the second set of logical channels; and

constructing either a first data unit associated with the first set of logical
15 channels or a second data unit associated with the second set of logical channels based on the comparison.

2. The method according to claim 1, further comprising determining whether transmission of the first data unit should be interrupted.

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3. The method according to claims 1 or 2, wherein the construction of either the first data unit or the second data unit is dependent on a highest priority between the

associated priority of the logical channel in the first set of logical channels and the associated priority of the logical channel in the second set of logical channels.

4. The method according to any of claims 1-3, wherein the first data unit or the second data unit comprises at least one medium access control control element relating to a third set of logical channels.

5. The method according to claim 4, wherein the at least one medium access control control element relating to the third set of logical channels corresponds to a buffer status report.

6. The method according to any of claims 1-5, wherein the determination is based on a maximum number of uplink transmissions that the communication device may concurrently perform, and whether a number of received overlapping grants is greater than or equal to a number of ongoing transmissions.

7. The method according to any of claims 1-6, wherein when an uplink transmission of the communication device overlaps in a time domain with one or more other uplink transmission channels, the method further comprises checking a new priority of a highest priority logical channel in the second set of logical channels.

8. The method according to any of claims 1-7, wherein when the new priority is higher than a priority of a highest priority logical channel of the first set of logical

channels mapped to the first data unit, the method further comprises processing an uplink transmission using a logical channel prioritization and constructing the second data unit.

5 9. The method according to any of claims 1-8, wherein when the new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is not processed further.

10 10. The method according to any of claims 1-9, wherein when the new priority is higher than a priority of a highest priority logical channel of the third set of logical channels, the method further comprises processing the uplink transmission using a logical channel prioritization and constructing the second data unit.

15 11. The method according to any of claims 1-10, wherein when the new priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink transmission is not processed further.

20 12. The method according to any of claims 1-11, wherein the communication device is configured by a network to compare the new priority with a priority of a highest priority logical channel of the third set of logical channels only, or a priority of a highest priority logical channel of both the first set of logical channels and the third set of logical channels.

13. The method according to any of claims 1-12,
wherein the first set of logical channels is applicable to a first received grant,
and
wherein the second set of logical channels is applicable to a second received
5 grant.

14. The method according to any of claims 1-13,
wherein the uplink transmission channel is indicated by the first received grant
or the second received grant, and
10 wherein the uplink transmission channel overlaps in time with the first
received grant or the second received grant.

15. The method according to any of claims 1-14, wherein the new priority is
determined based on the third set of logical channels when the new priority is higher
15 than a priority of a highest priority logical channel in the first set of logical channels.

16. A method, comprising:
handling a plurality of uplink grants applicable to a communication station;
assigning a first set of types of medium access control element contents to a
20 first uplink grant;
assigning a second set of types of medium access control element contents to
a second uplink grant; and

sending at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

17. The method according to claim 16,

5 wherein the first set of types of medium access control element contents is associated with at least a first set of logical channels, and

wherein the second set of types of medium access control element contents is associated with at least a second set of logical channels.

10 18. The method according to claims 16 or 17, wherein the first set of types of medium access control elements correspond to a buffer status report.

19. The method according to any of claims 16-18,

15 wherein a priority is allocated to each logical channel in the first set of logical channels, and

wherein another priority is allocated to each logical channel in the second set of logical channels.

20. A method, comprising:

20 handling a plurality of uplink grants applicable to a communication station;
assigning a first set of logical channels to a first uplink grant;
assigning a second set of logical channels to a second uplink grant; and

sending at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

21. An apparatus, comprising:

5 at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to:

receive a plurality of grants associated with a plurality of logical channels

10 applicable to the apparatus;

detect availability of data associated with a first set of logical channels, wherein each logical channel in the first set of logical channels comprises an associated priority;

detect availability of data associated with a second set of logical channels,

15 wherein each logical channel in the second set of logical channels comprises an associated priority;

compare the associated priority of a logical channel in the first set of logical channels with the associated priority of a logical channel in the second set of logical channels; and

20 construct either a first data unit associated with the first set of logical channels or a second data unit associated with the second set of logical channels based on the comparison.

22. The apparatus according to claim 21, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to determine whether transmission of the first data unit should be interrupted.

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23. The apparatus according to claims 21 or 22, wherein the construction of either the first data unit or the second data unit is dependent on a highest priority between the associated priority of the logical channel in the first set of logical channels and the associated priority of the logical channel in the second set of logical channels.

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24. The apparatus according to any of claims 21-23, wherein the first data unit or the second data unit comprises at least one medium access control control element relating to a third set of logical channels.

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25. The apparatus according to any of claims 21-24, wherein the at least one medium access control control element relating to the third set of logical channels corresponds to a buffer status report.

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26. The apparatus according to any of claims 21-25, wherein the determination is based on a maximum number of uplink transmissions that the apparatus may concurrently perform, and whether a number of received overlapping grants is greater than or equal to a number of ongoing transmissions.

27. The apparatus according to any of claims 21-26, wherein when an uplink transmission of the apparatus overlaps in a time domain with one or more other uplink transmission channels, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus at least to
5 check a new priority of a highest priority logical channel in the second set of logical channels.

28. The apparatus according to any of claims 21-27, wherein when the new priority is higher than a priority of a highest priority logical channel of the first set of
10 logical channels mapped to the first data unit, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to process an uplink transmission using a logical channel prioritization and construct the second data unit.

15 29. The apparatus according to any of claims 21-28, wherein when the new priority is lower than a priority of a highest priority logical channel of the first set of logical channels mapped to the first data unit, the uplink grant is not processed further.

30. The apparatus according to any of claims 21-29, wherein when the new
20 priority is higher than a priority of a highest priority logical channel of the third set of logical channels, the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to process

the uplink transmission using a logical channel prioritization and construct the second data unit.

31. The apparatus according to any of claims 21-30, wherein when the new
5 priority is lower than a priority of a highest priority logical channel of the third set of logical channels, the uplink transmission is not processed further.

32. The apparatus according to any of claims 21-31, wherein the apparatus is
configured by a network to compare the new priority with a priority of a highest
10 priority logical channel of the third set of logical channels only, or a priority of a highest priority logical channel of both the first set of logical channels and the third set of logical channels.

33. The apparatus according to any of claims 21-32,
15 wherein the first set of logical channels is applicable to a first received grant,
and
wherein the second set of logical channels is applicable to a second received grant.

20 34. The apparatus according to any of claims 21-33,
wherein the uplink transmission channel is indicated by the first received grant or the second received grant, and

wherein the uplink transmission channel overlaps in time with the first received grant or the second received grant.

35. The apparatus according to any of claims 21-34, wherein the new priority is determined based on the third set of logical channels when the new priority is higher than a priority of a highest priority logical channel in the first set of logical channels.

36. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to:

handle a plurality of uplink grants applicable to a communication station;

assign a first set of types of medium access control element contents to a first

uplink grant;

assign a second set of types of medium access control element contents to a second uplink grant; and

send at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

37. The apparatus according to claim 36,

wherein the first set of types of medium access control element contents is associated with at least a first set of logical channels, and

wherein the second set of types of medium access control element contents is associated with at least a second set of logical channels.

38. The apparatus according to claims 36 or 37, wherein the first set of types of medium access control elements correspond to a buffer status report.

39. The apparatus according to any of claims 36-38,
wherein a priority is allocated to each logical channel in the first set of logical channels, and

wherein another priority is allocated to each logical channel in the second set of logical channels.

40. An apparatus, comprising:

at least one processor; and

at least one memory including computer program code,

wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus at least to:

handle a plurality of uplink grants applicable to a communication station;

assign a first set of logical channels to a first uplink grant;

assign a second set of logical channels to a second uplink grant; and

send at least one information relating to the assignment of the first uplink grant or the second uplink grant to a communication device.

41. An apparatus, comprising:

means for performing at least the method according to any of claims 1-20.

42. An apparatus, comprising:

5 circuitry configured to cause the apparatus to perform at least the method
according to any of claims 1-20.

43. A computer readable medium comprising program instructions stored thereon
for performing at least the method according to any of claims 1-20.

1/4

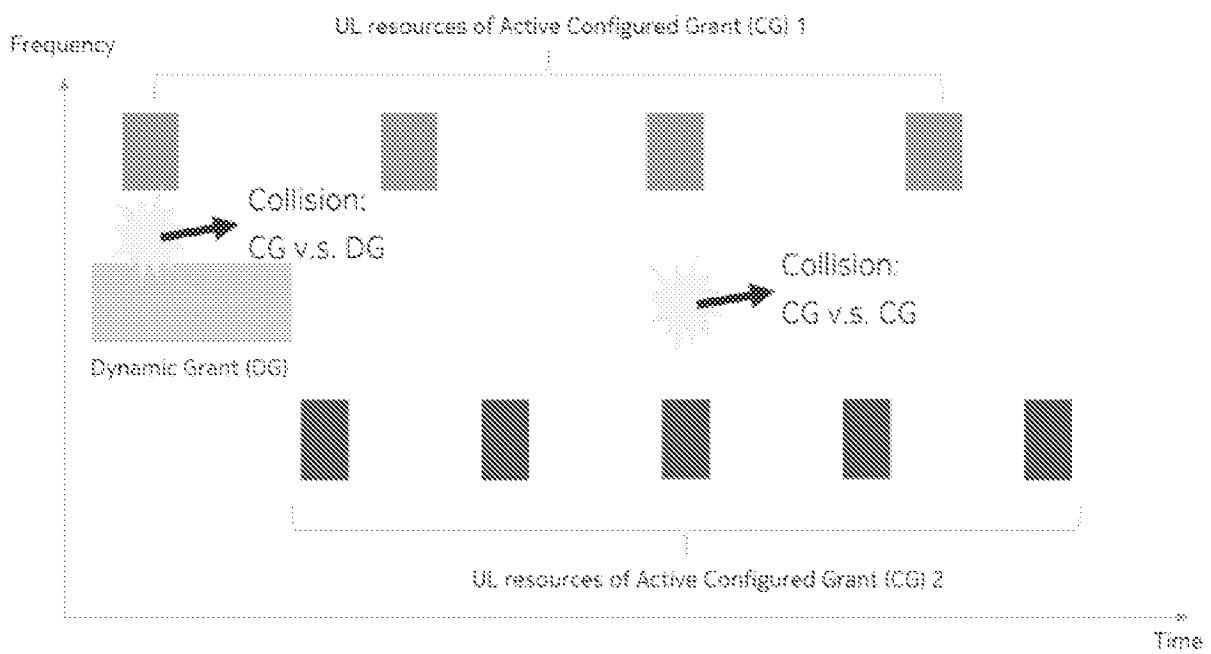


Fig. 1

2/4

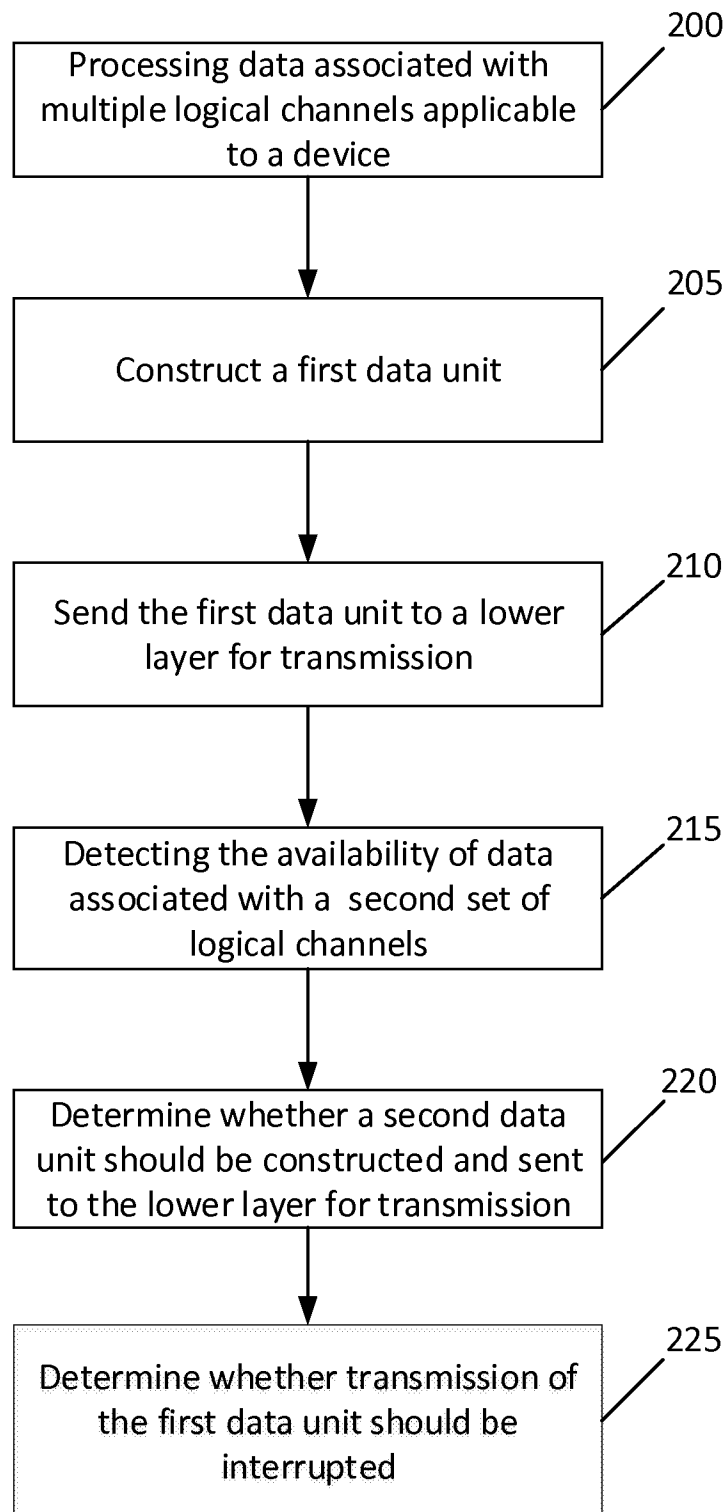


Fig. 2

3/4

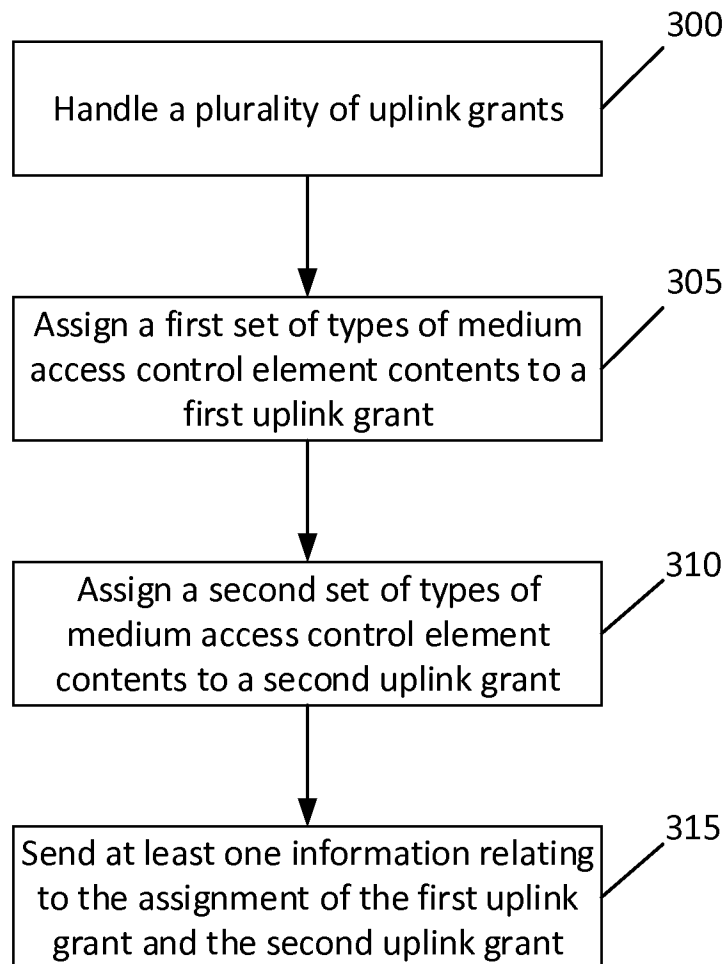
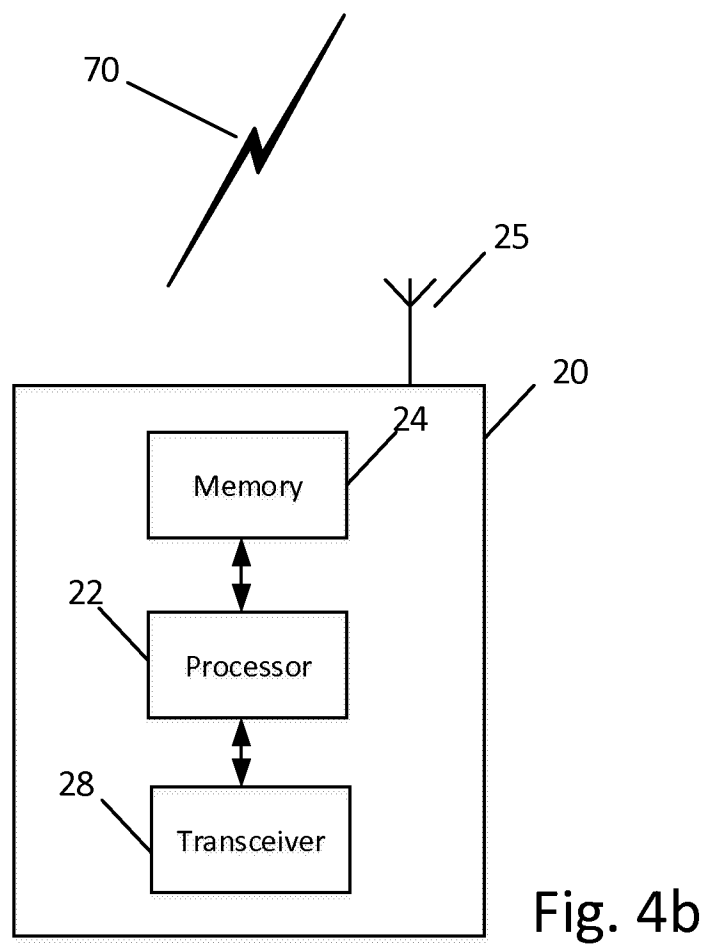
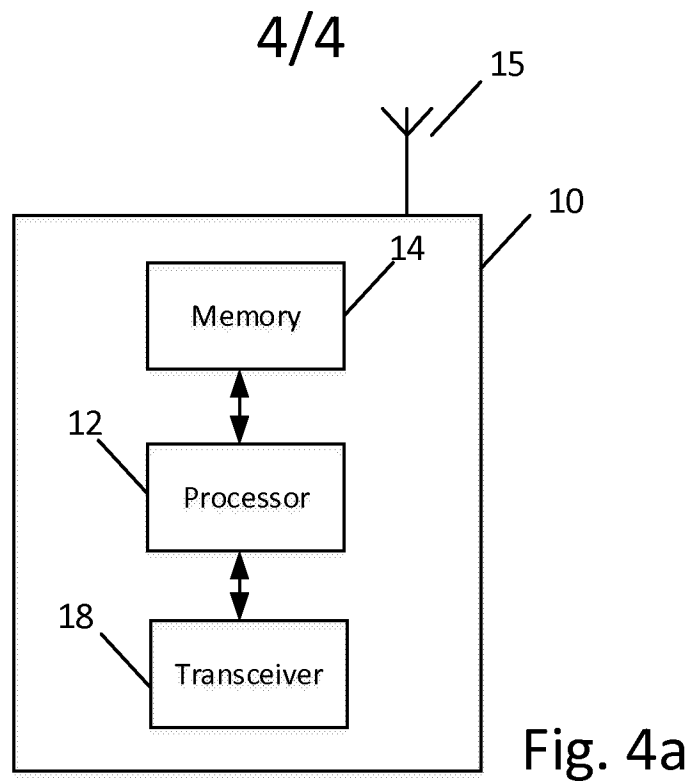


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2020/050005

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	VIVO: "Discussion on handling UL multiplexing of transmissions with different reliability requirements", 3GPP DRAFT; R1-1803848 DISCUSSION ON HANDLING UL MULTIPLEXING OF TRANSMISSIONS WITH DIFFERENT RELIABILITY REQUIREMENTS, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE vol. RAN WG1, no. Sanya, China; 20180416 - 20180420 15 April 2018 (2018-04-15), XP051426143, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings%5F3GP P%5FSYNC/RAN1/Docs/ [retrieved on 2018-04-15] paragraph [03.2]; figure 6	1-3, 6-15, 20-23, 26-35, 40-43
Y		4,5,24, 25
A	-/--	16-19,



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

18 March 2020

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2020/050005

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	paragraphs [2.2.1], [2.2.4], [2.2.5]	1-3, 6-23, 26-43
X	----- US 2018/098349 A1 (SUN HAITONG [US] ET AL) 5 April 2018 (2018-04-05)	16-20, 36-43
A	paragraphs [0092], [0093], [0107], [0108]	1-15, 21-35
A	----- INTERDIGITAL COMMUNICATIONS: "Logical Channel Prioritization with Multiple Numerologies for NR", 3GPP DRAFT; R2-1701185 (NR SI AI10212 LCP AND MAC MULTIPLEXING FOR MULTIPLE NUMEROLOGIES), 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHI , vol. RAN WG2, no. Athens, Greece; 20170213 - 20170217 12 February 2017 (2017-02-12), XP051211877, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN2/Docs/ [retrieved on 2017-02-12] paragraph [0003] ----- -/--	1-43

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2020/050005

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No

PCT/FI2020/050005

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